19 chapter

Sodium Determination Using Ion-Selective Electrodes, Mohr Titration, and Test Strips

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19.1 INTRODUCTION

19.1.1 Background

Sodium content of foods can be determined by various methods, including an ion-selective electrode (ISE), the Mohr or Volhard titration procedure, or indicator test strips. These methods are official methods of analysis for numerous specific products. All these methods are faster and less expensive procedures than analysis by atomic absorption spectroscopy or inductively coupled plasma-optical emission spectroscopy. This experiment allows one to compare sodium analysis of several food products by ISE, Mohr titration, and Quantab® Chloride Titrators.

19.1.2 Reading Assignment

Ward, R.E., and Legako, J.F. 2017. Traditional methods for mineral analysis. Ch. 21, in *Food Analysis*, 5th ed. S.S. Nielsen (Ed.), Springer, New York.

19.2 ION-SELECTIVE ELECTRODES

19.2.1 Objective

Determine the sodium content of various foods with sodium and/or chloride ion-selective electrodes.

19.2.2 Principle of Method

The principle of ISE is the same as for measuring pH, but by varying the composition of the glass in the sensing electrode, the electrode can be made sensitive to sodium or chloride ions. Sensing and reference electrodes are immersed in a solution that contains the element of interest. The electrical potential that develops at the surface of the sensing electrode is measured by comparing the reference electrode with a fixed potential. The voltage between the sensing and reference electrodes relates to the activity of the reactive species. Activity (A) is related to concentration (C) by $A = \gamma C$, where γ is the activity coefficient, which is a function of ionic strength. By adjusting the ionic strength of all test samples and standards to a nearly constant (high) level, the Nernst equation can be used to relate electrode response to concentration of the species being measured.

19.2.3 Chemicals

	CAS No.	*Hazards*
Ammonium chloride (NH_4Cl)	12125-02-9	Harmful
Ammonium hydroxide (NH_4OH)	1336-21-6	Corrosive, dangerous for environment
Nitric acid (HNO_3)	7697-37-2	Corrosive
Potassium nitrate (KNO_3)	7757-79-1	
Sodium chloride (NaCl)	7647-14-5	Irritant
Sodium nitrate ($NaNO_3$)	7631-99-4	Harmful, oxidizing

19.2.4 Reagents

(**If these solutions are not purchased, it is recommended that these solutions be prepared by the laboratory assistant before class.)

Note: You can use a chloride and/or sodium ion-selective electrode, with the appropriate associated solutions (commercially available from companies that sell the electrodes): electrode rinse solution, ionic strength adjuster, reference electrode fill solution, standard solution, and electrode storage solution.

- Electrode rinse solution**
  For sodium electrode, dilute 20-mL ionic strength adjuster to 1 L with deionized distilled (dd) water. For chloride electrode, deionized distilled water.
- Ionic strength adjuster (ISA)
  For sodium electrode, 4M NH_4Cl and 4M NH_4OH. For chloride electrode, 5M $NaNO_3$.
- Nitric acid, 0.1N
  Dilute 6.3-mL conc. HNO_3 to 1 L with dd water.
- Reference electrode fill solution**
  For sodium electrode, 0.1M NH_4Cl. For chloride electrode, 10% KNO_3.
- Standard solutions**: 1000 ppm, sodium and/or chloride
  Use the 1000 ppm sodium or chloride solution to prepare 50 mL for each of the following concentrations: 10, 20, 100, 500, and 1000 ppm sodium or chloride.

19.2.5 Hazards, Precautions, and Waste Disposal

Adhere to normal laboratory safety procedures. Wear gloves and safety glasses at all times. Ammonium hydroxide waste should be discarded as hazardous waste. Other waste likely can be put down the drain using a water rinse, but follow good laboratory practices outlined by environmental health and safety protocols at your institution.

19.2.6 Supplies

- 16–18 Beakers, 250 mL (or sample cups to hold 100 mL)
- Food products: catsup, cottage cheese, potato chips, and sports drink (e.g., Gatorade, white or clear)
- Graduated cylinder, 100 mL
- Magnetic stir bars
- Pipette bulb or pump
- 3 Spatulas
- 16–18 Volumetric flasks, 100 mL
- 2 Volumetric flasks, 50 mL
- Volumetric pipette, 2 mL
- 9 Volumetric pipettes, 5 mL

- Watch glass
- Weighing paper

19.2.7 Equipment

- Analytical balance
- Direct concentration readout ISE meter (i.e., suitable meter with millivolt accuracy to 0.1 mV)
- Heating plate with stirrer
- Magnetic stirrer
- Chloride electrode (e.g., Van London-pHoenix Company, Houston, TX, Chloride Ion Electrode, Cat. # CL01502)
- Sodium electrode (e.g., Van London-pHoenix Company, Houston, TX, Sodium Ion Electrode, Cat. # NA71502)

19.2.8 Procedure

(Replicate the preparation and analysis of standards and samples as specified by an instructor.)

19.2.8.1 *Sample Preparation (General Instructions)*

1. Treat specific samples as described below (i.e., prehomogenized and/or diluted if necessary, as per Technical Services of ISE manufacturer), and then add 5 g or 5 mL of prepared sample to a 100-mL volumetric flask, then add dd 2-mL ISA, and dilute to volume with dd water. (See instructions specific for each type of food product below. Samples with high fat levels may require fat removal. Consult technical services of the company that manufactures the ISE.)

   Specific Samples:

   Sports drink: No dilution is required before use.

   Catsup: Accurately weigh ca. 1 g catsup into 50-mL volumetric flask, and dilute to volume with dd water. Mix well.

   Cottage cheese: Accurately weigh ca. 1 g of finely grated cheese into a 250-mL beaker containing a stir bar. Add 100-mL 0.1 *N* HNO_3. Cover beaker with a watch glass and boil gently for 20 min on stirrer/hot plate in a hood. Remove from hot plate and cool to room temperature in the hood.

   Potato chips: Accurately weigh ca. 5 g of potato chips into a 250-mL beaker. Crush chips with a glass stirring rod. Add 95-mL boiling dd water and stir. Filter water extract into a 100-mL volumetric flask, using a funnel with glass wool. Let cool to room temperature and dilute to volume.
2. Prepare standards by adding 5-mL standard of proper dilution (e.g., 10, 20, 100, 500, and 1000 ppm sodium or chloride) to a 100-mL volumetric flask. Add 2-mL ISA, then dilute to volume with dd water.

   Note: Sample/standard preparation calls for identical 1:20 dilution of each (i.e., 5 mL diluted to 100 mL). Therefore, since samples and standards are treated the same, no correction for this dilution needs to be made in calibration or calculation of results.

19.2.8.2 *Sample Analysis by ISE*

1. Condition sodium electrode as specified by the manufacturer.
2. Assemble, prepare, and check sodium and reference electrodes as described in electrode instruction manuals.
3. Connect electrodes to meter according to meter instruction manual.
4. For instruments with direct concentration readout capability, consult meter manual for correct direct measurement procedures.
5. Using the pH meter set on mV scale, determine the potential (mV) of each standard solution (10, 20, 100, 500, and 1000 ppm), starting with the most dilute standard. Use a uniform stirring rate, with a magnetic stir bar in each solution, placed on a magnetic stir plate.
6. Rinse electrodes with electrode rinse solution between standards.
7. Measure samples and record the mV reading. As you rinse electrodes with electrode rinse solution between measurements, be careful not to get rinse solutions into the hole for outer fill solution in the reference electrode (or ensure that the hole is covered).
8. After use, store sodium electrode and reference electrode as specified by manufacturer.

19.2.9 Data and Calculations

1. Prepare a standard curve, with electrode response plotted against concentration on a log scale. (Plot actual concentration values on the log scale, not log values.) Concentrations may be determined by reading directly off the standard curve or using a calculated equation of the line.
2. Use the standard curve and the mV readings for the samples to determine the sodium and/or chloride concentrations in ppm for the food samples as analyzed.
3. Convert the ppm sodium and/or chloride values for the food samples to mg/mL for the sports drink, catsup, cheese, and potato chips.
4. Taking into account the dilution of the samples, calculate the sodium and/or chloride content for catsup, cheese, and potato chips (in mg/g) (on a wet weight basis). Summarize the data

and calculated results in one table. Show all sample calculations below each table.
5. Calculate sodium chloride content of each food, based on the (a) chloride content and/or (b) sodium content.
6. Calculate the sodium content of each food, based on the sodium chloride content.
7. Compare the sodium/sodium chloride contents of the foods you analyzed to those reported in the US Department of Agriculture (USDA) Nutrient Database for Standard Reference (http://ndb.nal.usda.gov).

19.2.10 Question

1. If you used both a sodium and chloride ISE, which electrode worked better, concerning accuracy, precision, and time to response? Explain your answer, with appropriate justification.

19.3 MOHR TITRATION

19.3.1 Objective

Determine the sodium content of various foods using the Mohr titration method to measure chloride content.

19.3.2 Principle of Method

The Mohr titration is a direct titration method to quantitate chloride ions and then to calculate sodium ions. The chloride-containing sample solution is titrated with a standard solution of silver nitrate. After the silver from silver nitrate has complexed with all the available chloride in the sample, the silver reacts with chromate that has been added to the sample, to form an orange-colored solid, silver chromate. The volume of silver used to react with the chloride is used to calculate the sodium content of the sample.

19.3.3 Chemicals

	CAS No.	*Hazards*
Potassium chloride (KCl)	7447-40-7	Irritant
Potassium chromate (K_2CrO_4)	7789-00-6	Toxic, dangerous for environment
Silver nitrate ($AgNO_3$)	7761-88-8	Corrosive, dangerous for environment

19.3.4 Reagents

(**It is recommended that these solutions be prepared by laboratory assistant before class.)

- Potassium chloride
- Potassium chromate, 10% solution**
- Silver nitrate solution, ca. 0.1 *M* **
  Prepare approximately 400 mL of the ca. 0.1 *M* $AgNO_3$ (molecular weight (MW) 169.89) for each student or lab group. Students should accurately standardize the solution, as described in the Sect. 19.3.8.1.

19.3.5 Hazards, Precautions, and Waste Disposal

Wear gloves and safety glasses at all times, and use good lab technique. Potassium chromate may cause serious skin sensitivity reactions. The use of crystalline $AgNO_3$ or solutions of the silver salt can result in dark brown stains caused by photodecomposition of the salt to metallic silver. These stains are the result of poor technique on the part of the analyst, with spilled $AgNO_3$ causing discoloration of the floor. If you do spill this solution, immediately sponge up the excess solution and thoroughly rinse out the sponge at a sink. Then come back with the clean, rinsed sponge and mop up the area at least 3–4 times to remove all of the silver nitrate. Also, be sure to rinse all pipettes, burets, beakers, flasks, etc. to remove residual $AgNO_3$ when you are finished with this experiment. Otherwise these items also will stain, and drip stains are likely to appear on the floor. Potassium chromate and silver nitrate must be disposed of as a hazardous waste. Other waste likely can be put down the drain using a water rinse, but follow good laboratory practices outlined by environmental health and safety protocols at your institution.

19.3.6 Supplies

- 6 Beakers, 250 mL
- Brown bottle, 500 mL
- Buret, 25 mL
- 3 Erlenmeyer flasks, 125 mL
- 4 Erlenmeyer flasks, 250 mL
- Food products: cottage cheese (30 g), potato chips (15 g), and sports drink (15 mL) (e.g., Gatorade, white or clear)
- Funnel
- Glass wool
- Graduated cylinder, 25 mL
- Magnetic stir bars (to fit 125 or 250-mL flasks)
- Pipette bulb or pump
- Spatulas
- Weighing paper and boats
- Volumetric pipette, 1 mL

19.3.7 Equipment

- Analytical balance
- Hot plate
- Magnetic stir plate

19.3.8 Procedure

(Instructions are given for analysis in triplicate.)

19.3.8.1 *Standardization of ca. 0.1 M $AgNO_3$*

1. Transfer 400 mL of the 0.1 *M* $AgNO_3$ solution to a brown bottle. This solution will be standardized and then used to titrate the food samples. Fill a buret with this $AgNO_3$ solution.
2. Prepare the primary standard (KCl, MW = 74.55) solution in triplicate. Accurately weigh to four decimal places about 100 mg KCl into three 125-mL Erlenmeyer flasks. Dissolve in dd water (about 25 mL), and add 2–3 drops of K_2CrO_4 solution. (Caution: potassium chromate may cause serious skin sensitivity reactions!)
3. Put a magnetic stir bar in each flask with the KCl solution, and place the beaker on a magnetic stir plate below the buret for titration. Using the $AgNO_3$ solution in the buret, titrate the KCl solutions to the appearance of the first permanent, pale, pink-orange color. (Note: you will first get a white precipitate, then green color, and then the pink-orange color.) This endpoint is due to the formation of Ag_2CrO_4. The solution must be vigorously stirred during the addition of the $AgNO_3$ solution to avoid erroneous results.
4. Record volume of $AgNO_3$.
5. Calculate and record molarity of $AgNO_3$.

$$\frac{\text{g KCl}}{(\text{mL AgNO}_3)} \times \frac{1\,\text{mol KCl}}{74.555\,\text{g}} \times \frac{1000\,\text{mL}}{1\,\text{L}}$$
$$= M \text{ of } AgNO_3 / \text{L} = M\ AgNO_3$$

6. Label bottle of $AgNO_3$ with your name and the molarity of the solution.

19.3.8.2 *Sample Analysis by Mohr Titration*

Cottage Cheese

1. Accurately weigh 10 g of cottage cheese in triplicate into 250-mL beakers.
2. Add about 15 mL of warm dd water (50–55 °C) to each beaker. Mix to a thin paste using a glass stirring rod or spatula. Add another ca. 25-mL dd water to each beaker until the sample is dispersed.
3. Quantitatively transfer each solution to a 100-mL volumetric flask, rinsing beaker, and magnetic stir bar with dd water several times. Dilute to volume with dd water.
4. Filter each solution through glass wool. Transfer 50 mL of each solution to 250-mL Erlenmeyer flasks.
5. Add 1 mL of potassium chromate indicator to each 50 mL of filtrate.
6. Titrate each solution with standardized ca. 0.1 *M* $AgNO_3$, to the first visible pale red-brown color that persists for 30 s. Record the volume of titrant used.

Potato Chips

1. Weigh accurately approximately 5 g of potato chips in duplicate into 250-mL beakers, then add 95-mL boiling dd water to each beaker.
2. Stir the mixture vigorously for 30 s, wait for 1 min, stir again for 30 s, then let cool to room temperature.
3. Filter each solution through glass wool. Transfer 50 mL of each solution to 250-mL Erlenmeyer flasks.
4. Add 1 mL of potassium chromate indicator to each 50 mL of filtrate.
5. Titrate each solution with standardized ca. 0.1 *M* $AgNO_3$, to the first visible pale red-brown color that persists for 30 s. Record the volume of titrant used.

Sports Drink (Clear or White)

1. Pipette accurately 5 mL of sports drink in duplicate into 250-mL beakers, then add 95-mL boiling dd water to each beaker.
2. Stir the mixture vigorously for 30 s, wait 1 min, and stir again for 30 s.
3. Transfer 50 mL of each solution to 250-mL Erlenmeyer flasks.
4. Add 1 mL of potassium chromate indicator to each 50 mL of prepared sample.
5. Titrate each solution with standardized ca. 0.1 *M* $AgNO_3$, to the first visible pale red-brown color that persists for 30 s. Record the volume of titrant used.

19.3.9 Data and Calculations

1. Calculate the chloride content and the sodium chloride content of each replicated sample, then calculate the mean and standard deviation for each type of sample. Express the values in terms of percent, wt/vol, for the cottage cheese and potato chips, and percent, vol/vol, for the sports drink. Note that answers must be multiplied by the dilution factor.

$$\%\,\text{chloride} = \frac{\text{mL of } AgNO_3}{\text{g (or mL) sample}} \times \frac{\text{mol } AgNO_3}{\text{L}} \times \frac{35.5\,\text{g Cl}}{\text{mol NaCl}} \times \frac{1\,\text{L}}{1000\,\text{mL}} \times 100 \times \text{dilution factor}$$

$$\%\ \text{sodium chloride (salt)} = \frac{\text{mL of } AgNO_3}{\text{g (or mL) sample}} \times \frac{\text{mol } AgNO_3}{\text{liter}} \times \frac{58.5\,\text{g}}{\text{mol NaCl}} \times \frac{1\,\text{L}}{1000\,\text{mL}} \times 100 \times \text{dilution factor}$$

Sample	*Rep*	*Buret start (mL)*	*Buret end (mL)*	*Vol. $AgNO_3$ (mL)*	*% Cl*	*% NaCl*
Cottage cheese	1					
	2					
	3					
						$\bar{X}$ =
						SD =
Potato chips	1					
	2					
	3					
						$\bar{X}$ =
						SD =
Sports drink	1					
	2					
	3					
						$\bar{X}$ =
						SD =

19.3.10 Questions

1. Show the calculations of how to prepare 400 mL of an approximately 0.1*M* solution of $AgNO_3$ (MW = 169.89).
2. Would this Mohr titration procedure as described above work well to determine the salt content of grape juice or catsup? Why or why not?
3. How did this method differ from what would be done using a Volhard titration procedure? Include in your answer what additional reagents would be needed.
4. Would overshooting the endpoint result in an over- or underestimation of the salt content using the (a) Mohr titration or (b) Volhard titration?

19.4 QUANTAB® TEST STRIPS

19.4.1 Objective

To measure the chloride content of foods using Quantab® Chloride Titrators, then calculate the sodium chloride content.

19.4.2 Principle of Method

Quantab® Chloride Titrators are thin, chemically inert plastic strips. These strips are laminated with an absorbent paper impregnated with silver nitrate and potassium dichromate, which together form brown-silver dichromate. When the strip is placed in an aqueous solution that contains chlorine, the liquid rises up the strip by capillary action. The reaction of silver dichromate with chloride ions produces a white column of silver chloride in the strip. When the strip is completely saturated with the liquid, a moisture-sensitive signal across the top of the titrator turns dark blue to indicate the completion of the titration. The length of the white color change is proportional to the chloride concentration of the liquid being tested. The value on the numbered scale is read at the tip of the color change and then is converted to percent salt using a calibration table.

19.4.3 Chemicals

	CAS No.	*Hazards*
Sodium chloride (NaCl)	7647-14-5	Irritant

19.4.4 Reagents

- Sodium chloride stock solution
  Accurately weigh 5.00 g of dried sodium chloride and quantitatively transfer to a 100-mL volumetric flask. Dilute to volume with dd water and mix thoroughly.
- Sodium chloride standard solutions
  Dilute 2 mL of the stock solution to 1000 mL with dd water in a volumetric flask to create a 0.010% sodium chloride solution to use as a standard solution with the low range Quantab® Chloride Titrators.
  Dilute 5 mL of the stock solution to 100 mL with dd water in a volumetric flask to create a 0.25% sodium chloride solution to use as a standard solution with the high range Quantab® Chloride Titrators.

19.4.5 Supplies

- 5 Beakers, 200 mL
- Filter paper (when folded as a cone, should fit into a 200-mL beaker)
- Funnels
- Glass wool
- Glass stirring rod
- Graduated cylinder, 100 mL

- Quantab® Chloride Titrators, range: 0.05–1.0% NaCl; 300–6000 ppm Cl (High Range, HR) and 0.005–0.1% NaCl; 30–600 ppm Cl (Low Range, LR) (Environmental Test Systems/Hach Company, Elkhart, IN, 1-800-548-4381).
- Spatulas
- Sports drink, 10 mL (i.e., same one used in Sects. 19.2 and 19.3)
- 2 Volumetric flasks, 100 mL

19.4.6 Equipment

- Hot plate
- Top loading balance

19.4.7 Procedure

(Instructions are given for analysis in triplicate.)

19.4.7.1 *Standard Solutions of Sodium Chloride*

1. Transfer 50 mL of the 0.25% standard sodium chloride solution to a 200-mL beaker.
2. Fold a piece of filter paper into a cone-shaped cup and place it point end down into the beaker. This will allow liquid from the beaker to seep through the filter paper at the pointed end.
3. Using the 0.25% sodium chloride standard solution, place the lower end of the High Range Quantab® Strip (0.05–1.0%) into the filtrate within the pointed end of the filter paper cone, being sure not to submerge the titrator more than 1.0 in.
4. Thirty seconds after the moisture-sensitive signal string at the top of the titrator turns dark blue or a light brown, record the Quantab® reading at the tip of the yellow-white peak, to the nearest 0.1 units on the titrator scale.
5. Using the calibration chart included with the Quantab® package, convert the Quantab® reading to percent sodium chloride (NaCl) and to ppm chloride (Cl^-). Note that each lot of Quantab® has been individually calibrated. Be sure to use the correct calibration chart (i.e., the control number on the product being used must match the control number on the bottle).
6. Repeat Steps 1–5 given above (Sect. 19.4.7.1) using the 0.01% sodium chloride standard solution with the Low Range Quantab® Strip.

19.4.7.2 *Sample Analysis with Quantab® Test Strips*

Cottage Cheese

1. Weigh accurately approximately 5 g of cottage cheese into a 200-mL beaker, then add 95-mL boiling dd water.
2. Stir mixture vigorously for 30 s, wait for 1 min, stir again for 30 s, and then let cool to room temperature.
3. Fold a piece of filter paper into a cone-shaped cup and place it point end down the beaker. This will allow liquid from the beaker to seep through the filter paper at the pointed end.
4. Testing with both the Low Range and the High Range Quantab® Test Strips, place the lower end of the Quantab® into the filtrate within the pointed end of the filter paper cone, being sure not to submerge the titrator more than 2.5 cm.
5. Thirty seconds after the moisture-sensitive signal string at the top of the titrator turns dark blue or a light brown, record the Quantab® reading at the tip of the yellow-white peak, to the nearest 0.1 units on the titrator scale.
6. Using the calibration chart included with the Quantab® package, convert the Quantab® reading to percent sodium chloride (NaCl) and to ppm chloride (Cl^-). Note that each lot of Quantab® has been individually calibrated. Be sure to use the correct calibration chart (i.e., the control number on the product being used must match the control number on the bottle).
7. Multiply the result by the dilution factor 20 to obtain the actual salt concentration in the sample.

Potato Chips

1. Weigh accurately approximately 5 g of potato chips into a 200-mL beaker. Crush chips with a glass stirring rod. Add 95-mL boiling dd water and stir.
2. Filter water extract into a 100-mL volumetric flask, using a funnel with glass wool. Let cool to room temperature and dilute to volume. Transfer to a 200-mL beaker.
3. Follow Steps 3–7 from the procedure for cottage cheese, Sect. 19.4.7.2.

Catsup

1. Weigh accurately approximately 5 g of catsup into a 200-mL beaker. Add 95-mL boiling dd water and stir.
2. Filter water extract into a 100-mL volumetric flask. Let cool to room temperature and dilute to volume. Transfer to a 200-mL beaker.
3. Follow Steps 3–7 from the procedure for cottage cheese, Sect. 19.4.7.2.

Sports Drink

1. Weigh accurately approximately 5 mL of sports drink into a 200-mL beaker. Add 95-mL boiling dd water and stir.
2. Follow Steps 3–7 from procedure for cottage cheese, Sect. 19.4.7.2.

19.4.8 Data and Calculations

	From calibration chart				*Corrected for dilution factor*			
	% NaCl		*ppm Cl*		*% NaCl*		*ppm Cl*	
Rep	*LR*	*HR*	*LR*	*HR*	*LR*	*HR*	*LR*	*HR*
Catsup								
1								
2								
3								
					$\bar{X}$ = SD =	$\bar{X}$ = SD =	$\bar{X}$ = SD =	$\bar{X}$ = SD =
Cottage cheese								
1								
2								
3								
					$\bar{X}$ = SD =	$\bar{X}$ = SD =	$\bar{X}$ = SD =	$\bar{X}$ = SD =
Potato chips								
1								
2								
3								
					$\bar{X}$ = SD =	$\bar{X}$ = SD =	$\bar{X}$ = SD =	$\bar{X}$ = SD =
Sports drink								
1								
2								
3								
					$\bar{X}$ = SD =	$\bar{X}$ = SD =	$\bar{X}$ = SD =	$\bar{X}$ = SD =

19.5 SUMMARY OF RESULTS

Summarize in a table the sodium chloride content (mean and standard deviation) of the various food products as determined by the three methods described in this experiment. Include in the table the sodium chloride contents of the foods from the nutrition label and those published in the USDA Nutrient Database for Standard Reference (web address: http://ndb.nal.usda.gov/).

Sodium chloride content (%) of foods by various methods:

Food Product		*Ion-selective electrode*	*Mohr titration*	*Quantab® titrator*	*Nutrition label*	*USDA Database*
Catsup	$\bar{X}$ = SD =					
Cottage cheese	$\bar{X}$ = SD =					
Potato chips	$\bar{X}$ = SD =					
Sports drink	$\bar{X}$ = SD =					

19.6 QUESTIONS

1. Based on the results and characteristics of the methods, discuss the relative advantages and disadvantages of each method of analysis for these applications.
2. Comparing your results to data from the nutrition label and USDA Nutrient Database, what factors might explain any differences observed?

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RESOURCE MATERIALS

AOAC International (2016) Official methods of analysis, 20th edn. (On-line). Method 941.18, Standard solution of silver nitrate; Method 983.14, Chloride (total) in cheese. AOAC International, Rockville, MD

AOAC International (2016) Official methods of analysis, 20th edn. (On-line). Method 976.25, Sodium in foods for special dietary use, ion selective electrode method. AOAC International, Rockville, MD

AOAC International (2016) Official methods of analysis, 20th edn. (On-line). Method 971.19, Salt (chlorine as sodium chloride) in meat, fish, and cheese; Indicating strip method. AOAC International, Rockville, MD

Ward RE, Legako JF (2017) Traditional methods for mineral analysis. Ch. 21. In: Nielsen SS (ed) Food analysis, 5th edn. Springer, New York

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